Services Authorization No. 2023-021-01, MODIFICATION No. 1

under Research Agreement dated April 18, 2023

All of the terms and conditions of the Research Agreement between the parties dated April 18, 2023 are hereby incorporated by reference.

Project Name	Central Regional Utility Service Area – Central Water Treatment Facility Process Monitoring and Performance Assessment
Scope of Services	See attached Exhibit "A"
Duration (in days)	Approximately 510 additional days or 17 months; This authorization shall be in full force and effect until all services identified in Exhibit "A" are complete.
Compensation (Fixed Price/Lump Sum)	$162,900 (Original) + **$120,241 (Mod 1)** = $283,141 (TOTAL)
Special Contract Conditions (if any)	N/A
Budget Source/Availability	42011. 660536012.5331010 (Water Plant Operations/Treatment)

IN WITNESS WHEREOF, the parties hereto have executed this authorization on this __ day of _____, 2025.

ATTEST: Stacy M. Butterfield

By:_____
Deputy Clerk

Review as to form and legal sufficiency

_____
County Attorney's Office Date

POLK COUNTY, a political subdivision of the State of Florida

By:_____
Chairman, Board of County Commissioners

Date signed:_____

ATTEST:

By: Sarah J. McCaffrey
Name: Sarah J. McCaffrey
Its: Administrative Assistant II

Notary Public State of Florida
Sarah J. McCaffrey
My Commission HH 566811
Expires 7/9/2028

UNIVERSITY OF CENTRAL FLORIDA,
by and on behalf of its Board of Trustees

By: _____
Name: Joel Kennedy
Its: Associate Director, Sponsored Programs
Date Signed: 6/23/2025

Exhibit A

Scope of Services

Services Authorization No. 2023-021-01 MODIFICATION No. 1

Board of County Commissioners of Polk County

Central Regional Utility Service Area

Central Water Treatment Facility Process Monitoring and Performance Assessment

The University of Central Florida Board of Trustees (UCF), a public body corporate, organized under the State of Florida with an office located at 12201 Research Parkway, Suite 501, Orlando, Florida 32826 entered into a Research Agreement (AGREEMENT) with Polk County, Florida (COUNTY), a political subdivision of the State of Florida, on April 18, 2023. Pursuant to this AGREEMENT, the COUNTY has requested UCF's Department of Civil, Environmental and Construction Engineering (CECE) to assess process performance for the ozone and granular activated carbon (GAC) integrated processes at the COUNTY's Central Water Treatment Facility (PROJECT). The Central Water Treatment Facility (WTF) supplies the Central Region Utility Service Area (CRUSA) which is also comprised of other WTFs and interconnected systems. **Subsequent to AGREEMENT 2023-021-01"s original authorization on November 7, 2023, the COUNTY has requested UCF modify the timeline of the investigation to provide additional services with regards the Central WTF (PROJECT's Extended STUDY MODIFICATION).**

A. RESEARCH SCOPE

The COUNTY owns and operates a 4 million gallons per day (MGD) Central WTF that treats groundwater through ozone addition followed by GAC treatment prior to chlorination to remove total sulfide and to meet disinfection the Environmental Protection Agency's Safe Drinking Water Act disinfection by-products (DBPs) regulatory requirements. Approximately twenty percent of the ozonated flow is by-passed around the GAC system to extend the carbon bed's useful life. The plant was first placed on-line in November 2019. The COUNTY has requested that UCF CECE continue to assist in its ongoing evaluation that includes the monitoring and assessment of the COUNTY's Central WTF treatment combined processes. The purpose of this research is to continue to review the effectiveness of the ozone contact and destruct basin with respect to water quality, examine the condition of the activated carbon that comprises the GAC bed, assess the beds are microbiological removal effectiveness of DBP precursors, and evaluate finished water quality and impact of blending bypass into the distribution system in terms of organic, inorganic, and microbial quality entering the water distribution system.

PHASE 100 – PROJECT MANAGEMENT COMPONENT

Task 101 – Project Management and Communication

Continued coordination of UCF research activities with the COUNTY will be required for the PROJECT. This task consists of those needs required for project management for the STUDY to include scheduling and coordinating activities with the COUNTY and others (if required). UCF will communicate to COUNTY operations personnel UCF's data needs so that the appropriate means for gaining access to the appropriate sample location can be established; site-specific details regarding the differentiation between UCF-collected samples and COUNTY-collected samples will be clarified prior to any sampling activities being performed in support of STUDY. UCF quality assurance and quality (QA/QC) control methods will be implemented as the STUDY progresses.

Note: It is established herein that the COUNTY does not require a certification of the analysis for UCF's laboratories as this STUDY is considered non-regulatory applied research.

Task 102 – Site Visits and Progress Conference Calls

This work authorization will allow UCF to perform site visits at the Central WTF for at least twelve (12) site visits. Each site visit will require the collection of water samples by process location for DBP precursor matter (see Section E Responsibilities). In addition, a progress conference call will be held every other month to discuss project schedule and implementation needs.

PHASE 200 – RESEARCH COMPONENT

COUNTY will assist UCF in the collection of aqueous (process water streams) or solid (granular carbon media) process-related samples. UCF will provide the COUNTY with a 'script' (test plan) for the anticipated on-site sample activities, such as sample identification needs, sample bottle storage requirements and GAC sample frequency, as examples. Sample location access will vary depending on whether it is aqueous (e.g., raw supply; process stream; point-of-entry) or solid (activated carbon).

Task 201: Raw Water Supply Quarterly Sampling Events

General Water Quality. The COUNTY's Central WTF is supplied from three wells located on-site as shown in **Photo 1**. These three groundwater wells will be sampled four times (approximately each quarter) during the STUDY for the following water quality parameters: alkalinity, bromide, calcium, chlorine (residual), conductivity, iron, oxidation reduction potential (ORP), pH, sulfate, sulfide (Total), SUVA-254, temperature, total organic carbon (as DOC), turbidity, and UV-254. At the time of each sampling event, process operation related information (flow, time, location) will be collected. Analytical methods, sampling and storage requirements are provided in **Appendix A**.

Photo 1. One of three Central WTF On-site Wells.

Task 202: Process Evaluation

UCF will evaluate the Central WTF's ozone (oxidation system) and GAC (adsorption system) unit operations as described in this Task. Key operation water quality of interest for the ozone and GAC system may in part or whole include alkalinity, bromide, calcium, chlorine (residual), conductivity, iron, nitrate, oxidation reduction potential (ORP), pH, sulfate, sulfide (total), SUVA-254, temperature, total organic carbon (as DOC), turbidity, and UV-254.

Ozone System. The ozone process will be evaluated in terms of water quality and process-control mass transfer and performance effectiveness. Ozonation provides many benefits to the water treatment process, in particular dissolved organics removal (natural organic matter or NOM, and organic micropollutants). Ozone oxidation breaks down long chain molecules into short chained organics such as aldehydes, ketoacids, and carboxylic acids which are more easily biodegradable with the use of a downstream granular activated carbon (GAC). These organic byproducts serve as carbon source for bacteria. The ozone treatment process consists of an ozone generator, feed-gas supply, ozone contactor, and an ozone destruct system. Operation monitoring information (flow, time, location) is necessary for STUDY as well as effluent total trihalomethanes and haloacetic acids. This will include post-ozone evaluations for formaldehyde, acetaldehyde, glyoxal, and methyl glyoxal (the sum referred to as aldehydes), oxalate, and adenosine triphosphate (ATP). **Photo 2** presents a photograph of the ozone contact and destruct chamber.

Photo 2. The ozone contact and destruct chamber

GAC System. The activated-carbon process will be evaluated relative to its process operation performance. This will include process-control water quality evaluations (mass transfer parameter time-series comparisons), water quality, microbiological activity, and other adsorption conditions. There are two sample types which will be collected in this GAC subtask: (a) water quality samples; (b) solid GAC samples directly from the bed to be evaluated by (i) physical and (ii) microbiological means. The Model 12-40 Adsorption System is a unit consisting of one (1) vertical pressure vessel, containing 40,000 pounds of granular activated carbon (GAC); four of the Model 12-40 containers comprise the granular activated carbon process at the Central WTF; each of the four vessels are complete with underdrain and carbon transfer piping. **Photo 3** illustrates the number of and size of the GAC vessels at the facility.

Photo 3. Central WTF Adsorber GAC Adsorption Vessels

a) **Water Quality and Solid GAC Sample Collection Events.** Water will be collected from the 25%, 50% and 75% GAC vessel monitoring locations on each of the four vessels once per month for 13 months. TOC and UV-254 will be collected and correlated for operation needs. After each water sampling, the COUNTY will be required to remove the water sample tap covers at the 25%, 50% and 75% GAC vessel locations to obtain solid carbon media samples. It is planned to obtain the carbon solid samples necessary for the analysis in this component of the research via access to stainless-steel bed sampling locations, as depicted in **Figure 2.** A sampling protocol used for this work is attached as **Appendix B.** After the water quality and solid samples are obtained by UCF, stainless-steel sample ports (once disinfected) will be reinserted/reinstalled back to the GAC vessels by the COUNTY. Parameters of critical interest are TOC, UV-254, sulfate, calcium and alkalinity. Other parameters will be assessed in the investigation as required.

b) Solid Activated Carbon Analysis Collection Events

(i) ***Carbon integrity testing***. To determine how much wear and tear the units have been operating, solids will be assessed for parameter identified in manufacturer specifications. Approximately 250g of carbon will be collected at each of the bed depth sample ports; 25%, 50%, and 75% and will be submitted to the original manufacturer (Calgon Carbon Corporation, A Kuraray Company, 300 GSK Drive, Moon Township, PA 15108) to obtain abrasion resistance (particle integrity), particle size uniformity coefficient (effective size), ash content (inorganic quality), metals content (energy dispersive x-ray). An "Iodine" test for the carbon's surface oxide capacity will be performed (iodine number is a measure of the iodine adsorbed in the pores and, as such, is an indication of the pore volume available in the activated carbon of interest; typically, iodine numbers ranging from 600 to 1100). The results will be compared to historical values collected by the manufacturer at the last time that carbon replacement occurred.

(ii) ***Microbiological testing***. In treatment systems that are operated over longer periods of time, GAC surfaces can be colonized by microorganisms, which will eventually establish active biofilms, giving rise to the so-called biological activated carbon (BAC) process. To continue data evaluations related to identification of microbial species inhabiting the bed, additional testing will occur (CECE and UCF Chemistry Department will perform up to 2 separate evaluations). Approximately 50g of the carbon collected from the 25% and 75% bed depth sample ports will undergo microbial microbiome characterization to determine which microorganisms are present and if any major changes can be seen from prior sampling sessions. DNA will be extracted from GAC samples and sequenced on the Illumina-MiSeq platform and analyzed by the Qiime2 method. Should the budget allow, a limited use of qPCR will be employed to target specific biomarkers to determine what specific enzymatic functions are occurring with the filter beds. The sampling will be coordinated with the County as one unit will be taken out of service for a portion of the operating day so that solid carbon can be collected from one vessel.

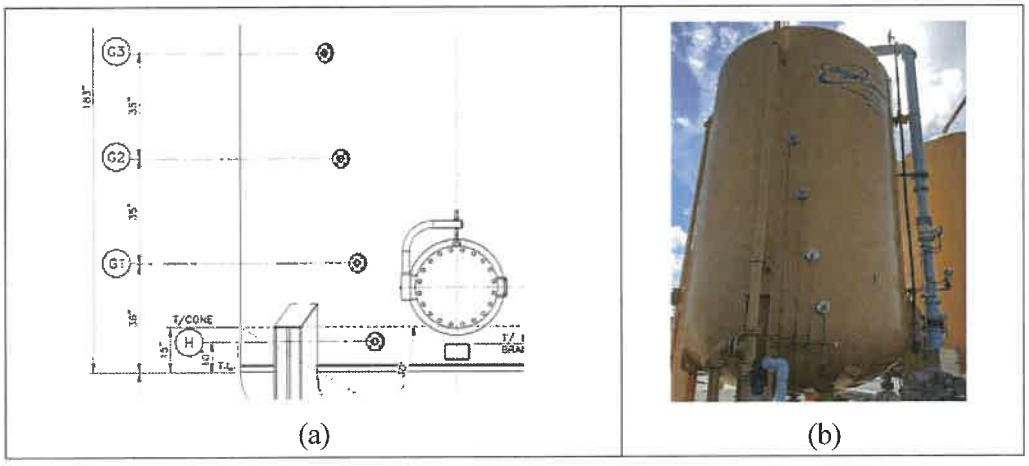

Photo 4. GAC Sample Port Detail (a) Schematic and (b) Vessel 1 Sample Port Locations.

Task 203: Data Compilation and Analysis

UCF will compile the analytical results and observations obtained during the STUDY and perform data analysis on the collected information, considering existing COUNTY or other entity historical data and information in this Task. The analysis will focus on the following: sulfide removal effectiveness of ozone addition; the condition of the activated carbon that comprises the GAC beds and their microbiologically active status; and project a carbon replacement timeline based on water quality uptake and breakthrough information. QA/QC and associated control charts will be developed for water quality parameters (where applicable). Precision and/or accuracy will be reported for specific parameters as needed.

PHASE 300 – REPORTING SERVICES

Task 301: Reporting Component

At the end of month 15 of the PROJECT's Modified STUDY (October 31, 2026), UCF will prepare an electronic version of a DRAFT REPORT and deliver to the COUNTY by e-mail for their review. The COUNTY will provide UCF with one set of combined comments of COUNTY-compiled draft review comments on the DRAFT REPORT within 14 days of receipt.

At the end of month 17 of the PROJECT's Amended STUDY (December 31, 2026), UCF will prepare and deliver to COUNTY a FINAL REPORT, considering COUNTY review comments of the DRAFT REPORT and report format quality requirements. A minimum of one hard copy and one electronic copy will be provided to the COUNTY at completion of the research via electronic mail.

Note: Additional reporting in the form "progress reports" every-other month.

B. SCHEDULE

MODIFICATION No. 1 is expected to require approximately 17 months per the schedule shown in **Table 1**, Schedule by Month. UCF will proceed with the services identified herein immediately upon receipt of an executed copy of this Authorization for MODIFICATION No. 1 from the County (the 17-month extension beginning August 1, 2025, and terminating December 31, 2026). This authorization shall be in full force and effect until the UCF completes all services as described herein and any subsequent modifications hereto.

Table 1. Schedule by Month for MODIFICATION No. 1

TASK	21 Mod-1 Start Aug 1, 2025	22 (TM1)	23	24 (TM2)	25	26 (TM3)	27	28 (TM4)	29	30 (TM5)	31	32 (TM6)	33	34 (TM7)	35	36	37 Mod-1 End Dec 31, 2026
Task 101. Project Management and Communication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Task 102. Site Visits	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Task 201: Raw Water Supply Quarterly Sampling Event	✓			✓			✓			✓							
Task 202: Process Evaluation (site visits)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Task 203: Data Compilation and Analysis				✓	✓			✓	✓		✓	✓		✓	✓		
Task 301: Reporting Component (check mark is progress updates, draft and final report stated)		✓		✓		✓		✓		✓		✓		✓	Draft Report		Final Report

C. DELIVERABLES

UCF will provide STUDY findings in a reasonable manner. **Table 2** presents an anticipated schedule of deliverable dates for the STUDY.

Table 2. Deliverables Schedule (Basis: 12 months)

DELIVERABLE ITEM	DUE DATE
a. Task 301. Initial Draft Report for Review by County	End Month 15 (October 31, 2026)
b. Task 301: Final Report	End Month 17 (December 31, 2026)
c. Task 301: Technical Memorandum (TM)	Every other Month (see Table 3 indicating 7 TM events)

D. COMPENSATION

The COUNTY will compensate UCF for the MODIFICATION No. 1 services described herein based on a lump-sum fee of $120,241. Accordingly, $7,073 shall be invoiced in 17 equal monthly installments commencing with the 21st month of the modified term for these services; the cost breakdown for the Amended STUDY is presented in **Table 3**. The Total cost (Original **$162,900** + MODIFICATION No. 1 of **$120,241**) will not exceed **$283,141** without prior mutual agreement of UCF and the COUNTY.

UCF Note: This is a TYPE 1 funded project; Invoicing will be based on an equal and incremental monthly invoice installment.

Table 3. UCF Research Cost for STUDY MODIFICATION No. 1

This research STUDY is a UCF Level (Type) 1 Project.

Task	Description (See Scope for Details)	Cost ($)
101	Project Management and Communication	$2,120
102	Site Visits and Progress Conference Calls	$3,750
201	Raw Water Supply Quarterly Sampling Events	$5,750
202	Process Evaluation	$97,015
203	Data Compilation and Analysis	$8,106
301	Reporting Components	$3,500
MODIFICATION No. 1	Mod.1	**$120,241**
Original Authorization	Original	**$162,900**
Total PROJECT	Total	**$283,141**

E. RESPONSIBILITIES

COUNTY will provide UCF with the following information and services.

- Process-related data gathering activities will require COUNTY and UCF technical personnel to discuss schedule for planning purposes. COUNTY will assist UCF in the collection of aqueous (process water streams) or solid (granular carbon) process-related samples.
- Copies of operations data related to the ozone and GAC process, specifically reports or analysis by the ozone manufacturer or it's representative entities for the Modified period.
- One copy (electronic or paper format) of state of Florida FDEP or Polk County Health Department (PCHD) distribution system water quality parameter quarterly reports for LCR and D/DBP total trihalomethane and haloacetic acid quarterly reports for the distribution system including the LRAA.

- Copies of data and information not associated with official FDEP or PCHD correspondence that is related to the WPF's operational history. UCF shall be allowed to make copies of the operator's daily log sheets (either by photograph or scan copy).
- COUNTY will coordinate activities related to UCF's research involvement to determine site visit times and locations; the COUNTY will provide official representation at meetings where UCF is on-site; meetings with UCF will not occur without the presence of the COUNTY project manager or official designee (operations staff) unless previously agreed.
- COUNTY will provide access to the COUNTY facilities and appurtenances associated with research efforts. The COUNTY will provide personnel to assist in support of the STUDY.

F. Quality Assurance and Quality Control

A quality assurance project plan (QAPP) documents the planning, implementation, and assessment procedures for a particular project, as well as any specific quality assurance and quality control activities. It integrates the technical and quality aspects of the project to provide a "blueprint" for obtaining the type and quality of environmental data and information needed for a specific decision or use. Adherence to the UCF laboratory QAPP will provide better assurance of the reliability and accuracy of the environmental data collected, evaluated, used, or reported during the course of the STUDY.

Sample collection and water quality analyses will be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* and the Environmental Protection Agency's *Methods for Chemical Analysis of Water and Wastes* and *Methods and Guidance for the Analysis of Water*. Only approved protocols will be used during the sample collection and evaluation program. This includes use of parameter specific holding times, container types, sample volumes, and preservative requirements.
Many of the activities performed by UCF will rely upon historical information such as water quality data and reports, in the implementation of this Project. UCF will follow its QAPP for field and laboratory facilities. UCF has developed its plan and is based in part on the document, Guidance for Quality Assurance Project Plans (EPA, Office of Environmental Information, EPA/240/R-02/009, December 2002). The plan has been developed to briefly describe basic activities involved with the acquisition of project information whether generated from direct measurement (laboratory or field) activities, collected from other sources, or compiled from computerized databases (should they exist). Qualitative data and information will also be relied upon in the conduct of this study.

In order to meet the objectives of the study, the QAPP will be utilized for the collection and analysis of data. Regarding the analytical testing of water samples, the appropriate portions of USEPA's Handbook of Analytical Quality Control in Water and Wastewater Laboratories and APHA-AWWA-WEF's Standard Methods for the Examination of Water and Wastewater (SM) shall be employed. In addition, the QAPP developed specifically for the project will be based on the following fundamental principles:

- The achievement of quality is the responsibility of both the person performing the work and his or her supervisor assigned to the work. The degree of application of the QAPP criteria is dependent on the impact of activity (planning, bench and pilot testing, maintenance, operation, etc.) on the objectives of the program. This is accomplished through the prudent use of "graded" quality assurance. The amount and extent of review of quality affecting activities will be commensurate with the importance of the activity to meeting the stated objectives of the overall program.
- Testing activities shall be controlled through the use of test plans, the use and adherence to test protocols and record keeping using technical notebooks and files.

Records and Data Management. The ultimate success of this project depends on the adequacy of the quality of the environmental data collected. For this project, existing and new data will be managed. Several sets of collections logs will be maintained during the field sample collection phase of the research program to document quality procedures that have been adhered to during implementation.

Data management tasks will be used to trace the path of the data from their generation in the field or laboratory to their final use and storage. Standard-of-care record keeping, document control and approaches used for data storage and retrieval on electronic media will be maintained during project implementation. The records, forms and data control methods of importance to the project include the following formats: Field Data Collection Records; Report of Analysis (from the laboratory); Operation Data Summary (taken at time of sampling); and, Instrument and Equipment Inspection, Maintenance and Calibration Logs.

Sample Collection. Sample collection and water quality analyses will be performed. Only approved protocols will be used during the sample collection and evaluation program. This includes use of parameter specific holding times, container types, sample volumes and preservative requirements. Sampling containers (including caps) that do not contain a preservative or dechlorinating agent will be rinsed with the water being collected prior to sample collection. The containers and caps will not be rinsed otherwise. The caps will be carefully handled during container filling to avoid sample contamination. Sufficient sample volumes as per the laboratory SOP will be collected to allow multiple measurements from the sample bottle if the results obtained in the field do not meet quality control (QC) requirements. Samples containing volatile compounds (if any) will be filled to eliminate headspace using appropriate sample containers with caps and Teflon-lined septas. The samples will be transported on the same day of sampling. Samples will be analyzed within appropriate holding times as identified with this QAPP, and proper records will be established for each water sample. Samples to be collected without headspace (to avoid aeration or constituent volatilization) will be checked for air bubbles immediately after sealing the container with the cap and septa. If air bubbles are found, the sample will be opened, filled with additional sample, and repeated until no bubbles are present.

Table A1 provides a typical summary of analytical methods for use in the field. This equipment will be calibrated in the lab or field on the same day of use, checked immediately prior to use in the field and recalibrated if necessary. Calibration will be checked approximately once every 2-hours throughout the duration of testing. These checks include the use of standard solutions (such as pH buffers and potassium iodide for conductivity) and/or blanks. Care will be taken to calibrate instruments approximating the anticipated range of measurement. Equipment calibration activities will be recorded within a field logbook. **Table A2** provides a partial listing of preservation and holding times for water quality analysis, and **Table A3** highlights the typical laboratory water quality analysis that may be performed and is tabulated in terms of the equipment used, the methodology applied, method detection limit, accuracy, precision, and sampling information including volume, container type, preservative and hold time.

G. Additional Provisions

If the research tasks required are different from those items presented herein, or if the COUNTY desires additional research, the resultant changes in scope will serve as a basis for amending the research scope as agreed to by the COUNTY and UCF. Additionally, UCF shall be entitled to rely upon the accuracy of data and information collected and provided by the COUNTY and others without independent review or evaluation. UCF is not responsible for the means, methods, sequences, techniques, or procedures of the COUNTY. Administrative and contractual points of contact for the Specific Authorization presented herein are as stated in the section, "Notices of the Research Agreement" of the Master Agreement.

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APPENDIX A

Table A-1. Summary of Analytical Methods Anticipated for Use in the Field (typical)

Test	Method Reference Number (Standard Methods); Instrument	Range / Resolution	Calibration Procedures
Chlorine, total and free	DR 890 Portable Colorimeter – SM 4500-Cl F DPD Colorimetric Method	0 – 5 mg/L Cl_2 range; 0.01 mg/L Cl_2 resolution	Use known concentrations of sodium hypochlorite into chlorine demand-free Milli-Q water (6-point calibration curve from 0 to 4 mg/L)
Conductivity	LaMotte Con 5 Field Probe (with temperature compensation)	0 – 20 mS Range 1 µS resolution	None
Dissolved Oxygen and (Oxidation Reduction Potential)	YSI 550A Sensor	0 – 50 mg/L O_2 Range	Calibrated against manufacturer's internal method and frequent membrane inspection
Hydrogen Sulfide	LaMotte 4630 Drop Count Method	0.01 mg/L S resolution	Check with samples collected for laboratory analysis using zinc acetate preservation method.
pH	LaMotte pH 5 Series Field probe (with temperature compensation)	0 – 14 Range, 0.01 resolution	Commercial pH calibration buffers, pH 4, 7, 10. Calibrated prior to analyzing any batch of samples using 2-point calibration with standard buffers
Temperature	Mercury-filled Celsius Thermometer	0 – 100 °C; 0.1 °C resolution	Calibrated against NIST-certified thermometer
Turbidity	EPA 180.1 Nephelometric Turbidity	0.01-800 NTUs 0.01	Calibrated daily with 10 NTU and full curve annually and as needed.

SM = Standard Methods; N/A = Not Applicable

Table A-2: Preservation and holding times for water quality analysis (typical)

Parameter	Collection Amount/ Vessel	Preservative	Holding Time
Alkalinity	200 mL plastic or glass	Refrigerate 4 °C	14 days
Anions	100 mL plastic or glass	Refrigerate 4 °C	28 days
Cations	100 mL plastic	HNO_3 to pH < 2	6 months
pH	50 mL plastic or glass	N/A	Analyze Immediately
TOC	100 mL glass	Refrigerate 4 °C H_3PO_4 to pH < 2	7 days
UV_{254}, Color, Turbidity	100 mL plastic or glass	N/A	Analyze Immediately

APPENDIX A

Table A-3: UCF CECE Drinking Water Laboratory Water Quality Analysis Summary Table (Preliminary)

Test	Method Reference Number (Standard Method); Instrument	Method Reporting Level (MRL)	Method Detection Level goal (MDL)	Accuracy % Recovery	Precision % RPD	Hold time (HT)	Minimum Sample Vol. (SV)	Cont. Type (CT)[1]	Preservative
Adenosine Triphosphate (ATP)	Promega GloMax® Luminometer and sample Kit	RLUs	RLUs	N/A	<20	None	24 mL	Sterile, ATP Free	24-hrs. in Lysis Solution. Keep out of sun.
Alkalinity	SM: 2320 B. Titration Method Bromocresol green/ methyl red	5 mg/L as CaCO3	5 mg/L as CaCO3	N/A	<20	Preferably 24 hours 14 days max.	100 mL	Glass or Plastic (filled completely and capped)	Cool, 4°C
Barium	EPA 200.7 / SM: 3120 B. Inductively Coupled Plasma (ICP) Method/Inductively Coupled Plasma Spectrometer	0.01 mg/L	0.002 mg/L	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; Acidify with 2% concentrated HNO3 to pH < 2
Bromide	EPA 300.0 / SM: 4110 B. Ion Chromatography (IC) with Chemical Suppression of Eluent Conductivity	0.01 mg/L	0.01mg/l	80-120	< 20	28 days	125 mL	Plastic	Cool, 4°C
Calcium	EPA 200.7 / SM: 3120 B. Inductively Coupled Plasma (ICP) Method/Inductively Coupled Plasma Spectrometer	0.01 mg/L	0.01 mg/L	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; Acidify with 2% concentrated HNO3 to pH < 2
Calcium Hardness	SM: 2340 C.EDTA Titrimetric Method	5.0 mg/L as Ca CO3	0.300 mg/L as Ca CO3	80-120	<20	180 days	250 mL	Plastic or Glass	1-mL HNO3, pH < 2
Chlorine, total and free	4500-Cl G DPD Colorimetric Method; Pocket Colorimeter II	0.10 mg/L	0.034 mg/L	80-120	< 20	analyze upon collection	250 mL	Amber Glass	Analyze immediately Cool, 4oC (Analyzed on the day of collection)
Chloride	EPA 300.0 / SM: 4110 B. Ion Chromatography (IC) with Chemical Suppression of Eluent Conductivity	0.10 mg/L	0.004 mg/L	80-120	<20	28 days	500 mL	Plastic or Glass	Cool, 4°C
Color (True)	SM: 2120 C. Single Wavelength Method (254 nm)	1 cpu	1 cpu	N/A	N/A	24 hours	100 mL	Plastic or Glass	None

Table A-3: UCF CECE Drinking Water Laboratory Water Quality Analysis Summary Table (Preliminary)

Test	Method Reference Number (Standard Method); Instrument	Method Reporting Level (MRL)	Method Detection Level goal (MDL)	Accuracy % Recovery	Precision % RPD	Hold time (HT)	Minimum Sample Vol. (SV)	Cont. Type (CT)[1]	Preservative
Conductivity	2510B. Laboratory Method; Fisher Scientific Traceable Conductivity, Resistivity and TDS Meter 2510B; HACH Conductivity Probe; Model 51975-03	N/A	N/A	N/A	<5	28 days	125 mL	Plastic or Glass	Cool, 4°C; Read at room temperature.
Fluoride	EPA 300.0 / SM: 4110 B. Ion Chromatography (IC) with Chemical Suppression of Eluent Conductivity	0.01 mg/L	0.002 mg/L	80-120	<20	28 days	500 mL	Plastic or Glass	Cool, 4°C
HAA5	SM: 5710 C. Simulated Distribution System Trihalomethanes	1-4 µg/L	3 µg/L	70-130	±30	14 days	1 L	Amber glass	Cool, 4°C
Hardness (Total)	SM: 2340 B. Hardness by Calculation	3.0 mg/L as $CaCO_3$	0.346 mg/L as $CaCO_3$	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; 1-mL HNO_3, pH < 2
Iron (Total and Dissolved)	EPA 200.7 / SM: 3120 B. Inductively Coupled Plasma (ICP) Method/Inductively Coupled Plasma Spectrometer	0.005 mg/L	0.007 mg/L	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; Acidify with 2% concentrated HNO_3 to pH < 2
Magnesium	EPA 200.7 / SM: 3120 B. Inductively Coupled Plasma (ICP) Method/Inductively Coupled Plasma Spectrometer	0.1 mg/L	0.03 mg/L	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; Acidify with 2% concentrated HNO_3 to pH < 2
Nitrate	EPA 300.0 / SM: 4110 B. Ion Chromatography (IC) with Chemical Suppression of Eluent Conductivity	0.01 mg/L as N	0.027 mg/L as N	80-120	<20	48 hrs.	500 mL	Plastic or Glass	Cool, 4°C
pH	SM: 4500-HB. Electrometric Method / E150 HACH Platinum pH Electrode, Model 51910, HQ40d Portable pH,	0.01 units	0.01 units	N/A	±0.1 pH unit	0.25 hr.	125 mL	Plastic or Glass	Analyze immediately
Sodium	EPA 200.7 / SM: 3120 B. Inductively Coupled Plasma (ICP) Method/Inductively Coupled Plasma Spectrometer	0.03 mg/L	0.03 mg/L	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; Acidify with 2% concentrated HNO_3 to pH < 2

Table A-3: UCF CECE Drinking Water Laboratory Water Quality Analysis Summary Table (Preliminary)

Test	Method Reference Number (Standard Method); Instrument	Method Reporting Level (MRL)	Method Detection Level goal (MDL)	Accuracy % Recovery	Precision % RPD	Hold time (HT)	Minimum Sample Vol. (SV)	Cont. Type (CT)[1]	Preservative
Strontium	EPA 200.7 / SM: 3120 B. Inductively Coupled Plasma (ICP) Method/Inductively Coupled Plasma Spectrometer	0.005 mg/L	0.0005 mg/L	80-120	<20	180 days	250 mL	Plastic or Glass	Cool, 4°C; Acidify with 2% concentrated HNO3 to pH < 2
Sulfide (Total)	LaMotte 4630 Drop Count Method (DR900)	0.01 mg/L	0.01 mg/L	N/A	<20	None	250 mL	Plastic or Glass	Collect without Aeration, Analyze immediately
Sulfate	EPA 300.0 / SM: 4110 B. Ion Chromatography (IC) with Chemical Suppression of Eluent Conductivity	0.01 mg/L	0.01 mg/L	80-120	<20	28 days	500 mL	Plastic or Glass	Cool, 4°C
Temperature	SM: 2550 B. Laboratory Method/ HQ40d Portable pH, Conductivity and Temperature Probe	0.1 °C	0.01 °C	N/A	NIST approved	None	125 mL	Glass / Plastic	Analyze immediately
Total Dissolved Solids (TDS)	SM: 2520 B. Electrical Conductivity Method; Fisher Scientific Traceable Conductivity, Resistivity and TDS Meter / SM: 2540C	10 mg/L / 1 mg/L	7.661 mg/L / 4 mg/L	N/A	<10	7 days	125 mL	Plastic	Cool, 4°C
Total Organic Carbon (as NPDOC)	SM: 5310 C. Persulfate-Ultaviolet Oxidation Method/Tekmarr-Dohrmann Phoenix 8000: The UV-Persulfate TOC Analyzer	0.1 mg/L	0.01 mg/L	80-120	<10	Preferred 24-hrs; limit 7-days	100 mL	Plastic	Analyze immediately; Or add HCl, H3PO4 or H2SO4 to pH<2, Cool, 4°C
TTHMs	SM: 5710 C. Simulated Distribution System Trihalomethanes	0.5-4 µg/L	1-3 µg/L	80-120	±30	14 days	1 L	Amber glass	Cool, 4°C
Turbidity	SM: 2130 B. or EPA 180.1 Nephelometric Method	0.02 - 0.05 NTU	0.012 NTU	N/A	<10	48 hrs.	100 mL	Plastic/ Glass	For best results, analyze immediately without altering sample; If storage is required, cool to 4°C.
UV-254 UV- Absorbing Organic Constituents	SM: 5910 B. Ultraviolet Absorption Method	0.009 cm^{-1}	0.001 cm^{-1}	80-120	20 (0.5 mg/L DOC)	48 hr.	125 mL	Amber glass bottle, Cap-Teflon lined	For best results, analyze samples as soon as possible. If storage is required, cool to 4°C.

APPENDIX B

Water Sampling Locations (May be Amended During STUDY)

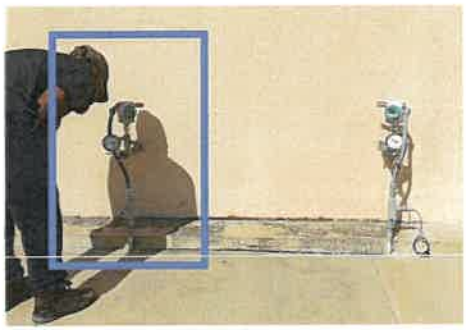
Prepared by Dr. Duranceau's Water Quality Engineering Research Group
Civil, Environmental and Construction Engineering Department, University of Central Florida

Purpose: Sample sites have been identified for project for collection of waters to assess dissolved organic carbon (DOC), UV254 and other water qualities in support of understanding the Granular Activated Carbon (GAC) contact units onsite for treatment of groundwater to control Disinfection by-product (DBP) formation by the removal of precursors measured as DOC. This is a list of the sites by photos to allow people less familiar with the site to sample water in glass amber bottles to return to UCF for analysis.

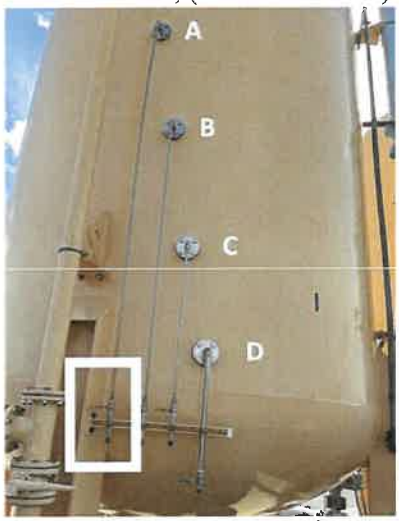
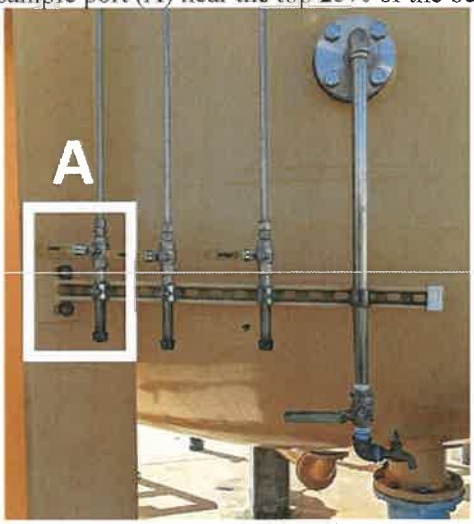
Sampling Protocol: Use an Amber glass bottle with cap, 1. Open bottle, do not touch the inside of the bottle or the cap (if need wear gloves), 2. Rinse the bottle and cap with the sample water 2-3 times, 3. Fill bottle near full and cap, 4. Store in a refrigerator – 4 deg C preferable (39 deg F), until collection by UCF.

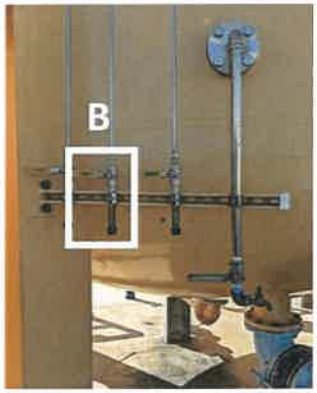
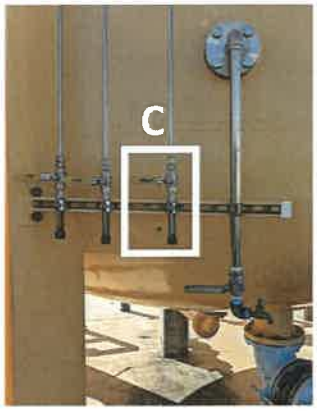
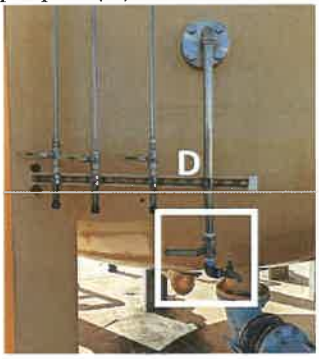
- *Be careful while sampling the GAC vessels. DO NOT let the water flush to quickly or for more than a few seconds before slowing the flow, collect the water within 30 sec to 1 minute to minimize the channelization within the bed (GAC vessels).*
- Central Regional Water Process Facility (WPF) is located at 1655 Old Bartow Eagle Lake Rd, Bartow, FL 33830. Initial site photographs during the original construction and taken over time are presented herein.

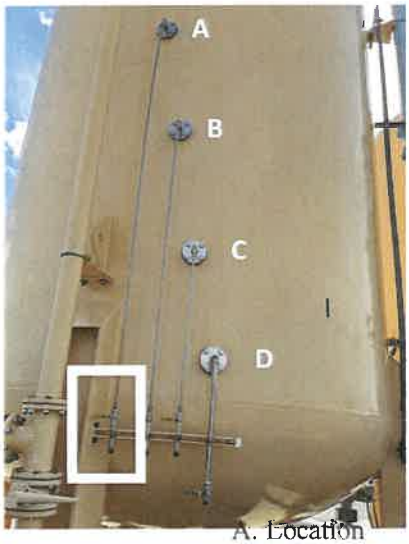
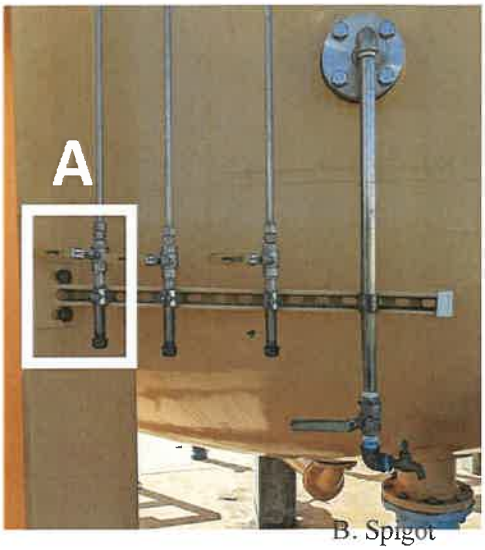
Table 1. Sample port location at the Central Regional Water Treatment Facility (Location May Change Per Visit)

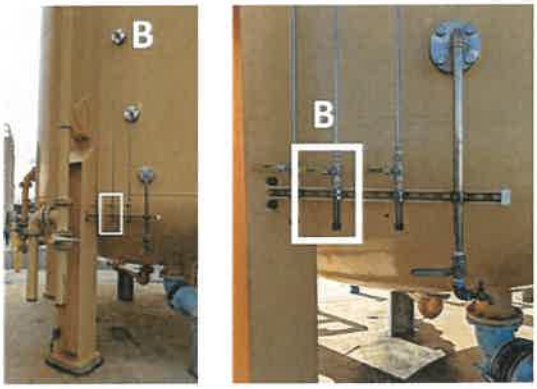
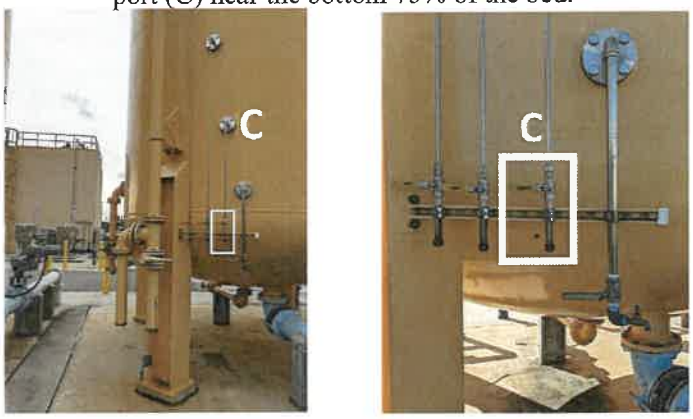
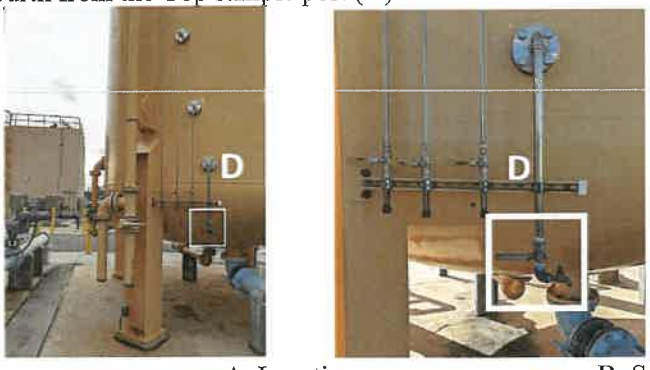
Sample port		
No.	**Ref. ID**	**Spigot Type and Location Description**
1	**Raw**	Raw water tap nested on the air release value on the turn of the pipe coming from the ground, a combination of mixed ground water from up to three wells.  A. Location  B. Spigot
2	**Oz 1**	Ozone destruct chamber 1 (facing the sample ports, left side). Operator Mr. Washington looking at left side, Oz 1.  A. Location  B. Spigot

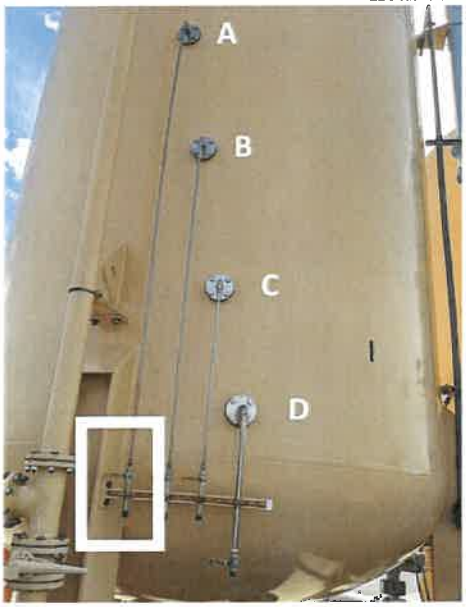
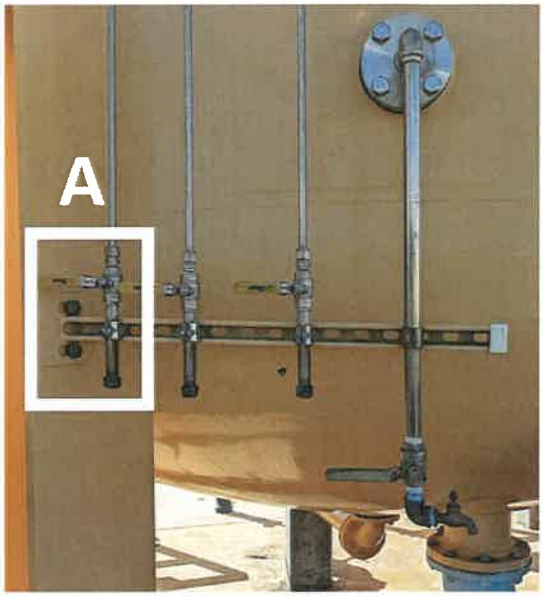
3	**Oz 2**	Ozone destruct chamber 2 (facing the sample ports, right side). Opposite of the sample port Operator Mr. Eckert is observing (left sample port, Oz 1)  A. Location  B. Spigot
4	**By-pass**	Water from the ozone destruct tank (two chambers mixed) that by-passes the GAC vessels, pipe prior to the entrance to the ground, prior to mixing with GAC treated waters. Note: the by-pass line sample ports spigots have been changed to the picture spigot Note: across from GAC Feed line (GAC IN) and same spigot  A. Location  B. Spigot

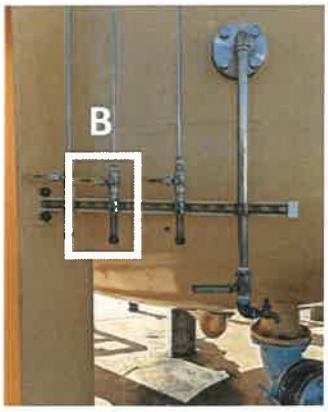
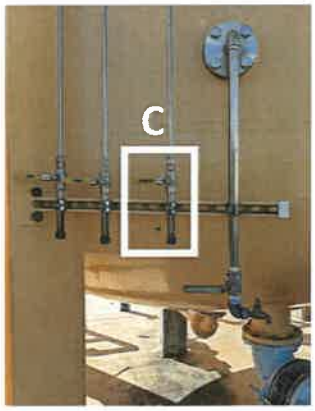
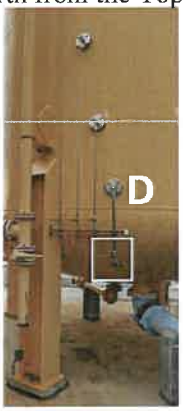
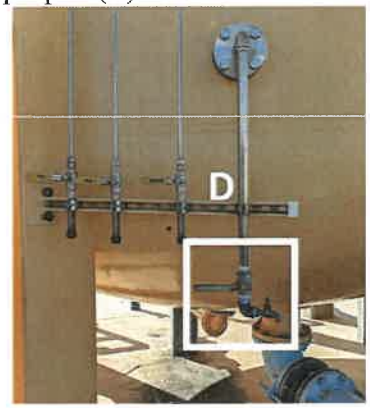
5	**GAC In**	Water from the ozone destruct tank (two chambers mixed) that feeds the GAC vessels. Note: the GAC feed line sample ports spigots have been changed to the picture spigot Note: across from GAC Bypass line and same spigot  A. Location  B. Spigot
6-26	**Intro to GAC Vessels**	The Granular Activated Carbon (GAC) Contact Chambers (Vessels) are labeled 1-4 on the vessel from the roadside view on the manhole, circle access point. Re-labeled here-in for easily viewing. GAC-1 (shown in orange) is located closest to the ozone destruct tank and GAC-4 is located closest to the storage shed. 
6	**GAC 1A**	GAC Vessel no. 1, (around backside) Top sample port (A) near the top 25% of the bed.  A. Location  B. Spigot

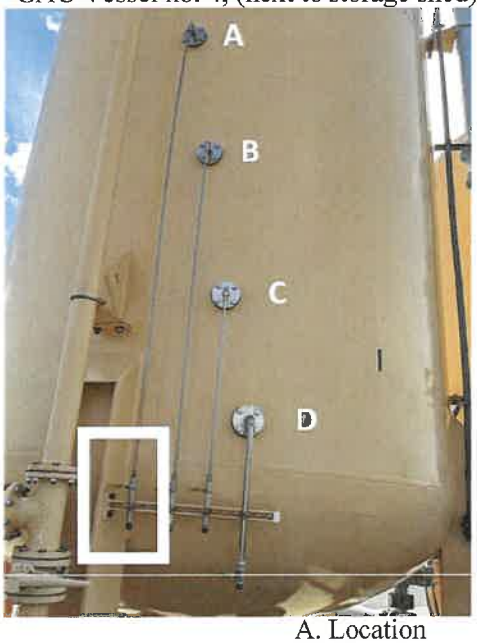
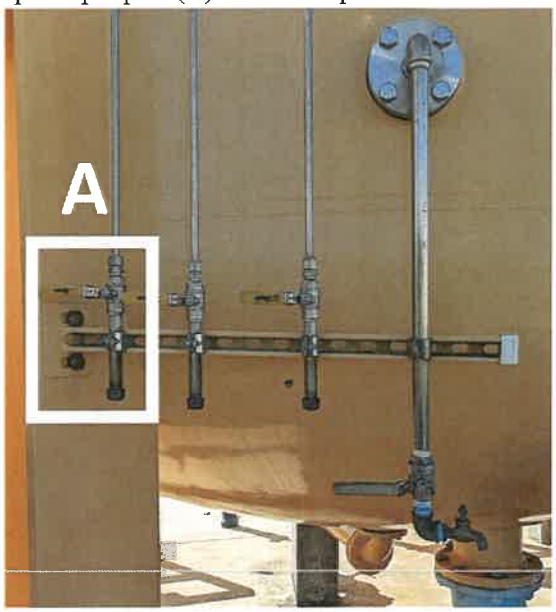
7	**GAC 1B**	GAC Vessel no. 1, (around backside opposite the Ozone destruct tank) Second to Top sample port (B) near the mid 50% of the bed.   A. Location B. Spigot
8	**GAC 1C**	GAC Vessel no. 1, (around backside opposite the Ozone destruct tank) Third to Top sample port (C) near the bottom 75% of the bed.   A. Location B. Spigot
9	**GAC 1D**	GAC Vessel no. 1, (around backside opposite the Ozone destruct tank) Lowest port on the Vessel, Fourth from the Top sample port (D) near the bottom 90% of the bed.   A. Location B. Spigot

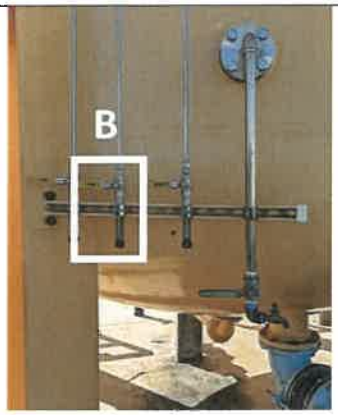
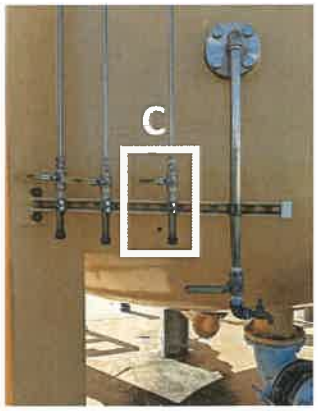
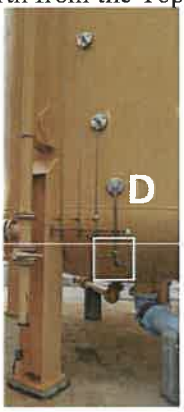
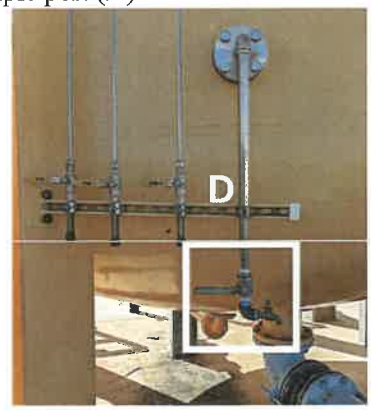
10	**GAC 1 OUT**	GAC 1 OUT sample port is located on the pipe exiting the GAC vessel. This port is tapped on the pipeline.  A. Location  B. Spigot
11	**GAC 2A**	GAC Vessel no. 2, (around backside opposite the Ozone destruct tank) Top sample port (A) near the top 25% of the bed.  A. Location  B. Spigot

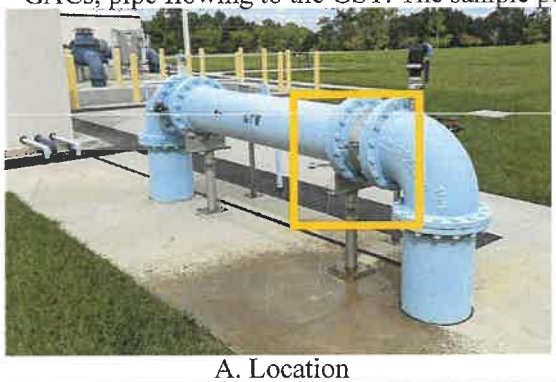
12	**GAC 2B**	GAC Vessel no. 2, (around backside opposite the Ozone destruct tank) Second to Top sample port (B) near the mid 50% of the bed.  A. Location B. Spigot
13	**GAC 2C**	GAC Vessel no. 2, (around backside opposite the Ozone destruct tank) Third to Top sample port (C) near the bottom 75% of the bed.  A. Location B. Spigot
14	**GAC 2D**	GAC Vessel no. 2, (around backside opposite the Ozone destruct tank) Lowest port on the Vessel, Fourth from the Top sample port (D) near the bottom 90% of the bed.  A. Location B. Spigot

15	**GAC 2 OUT**	GAC Vessel no. 2 is located second closest to the ozone destruct tank. GAC 2 OUT sample port is located on the pipe exiting the GAC vessel.  A. Location  B. Spigot
16	**GAC 3A**	GAC Vessel no. 3, (around backside opposite the Ozone destruct tank) Top sample port (A) near the top 25% of the bed.  A. Location  B. Spigot

17	**GAC 3B**	GAC Vessel no. 3, (around backside opposite the Ozone destruct tank) Second to Top sample port (B) near the mid 50% of the bed.   A. Location B. Spigot
18	**GAC 3C**	GAC Vessel no. 3, (around backside opposite the Ozone destruct tank) Third to Top sample port (C) near the bottom 75% of the bed.   A. Location B. Spigot
19	**GAC 3D**	GAC Vessel no. 2, (around backside opposite the Ozone destruct tank) Lowest port on the Vessel, Fourth from the Top sample port (D) near the bottom 90% of the bed.   A. Location B. Spigot
20	**GAC 3 OUT**	GAC Vessel no.3 is located second closest to the storage shed. GAC 3 OUT sample port is located on the pipe exiting the GAC vessel.

		 A. Location  B. Spigot
21	**GAC 4A**	GAC Vessel no. 4, (next to storage shed) Top sample port (A) near the top 25% of the bed.  A. Location  B. Spigot
22	**GAC 4B**	GAC Vessel no. 4, (next to storage shed) Second to Top sample port (B) near the mid 50% of the bed.

		  A. Location B. Spigot
23	**GAC 4C**	GAC Vessel no. 4, (next to storage shed) Third to Top sample port (C) near the bottom 75% of the bed.   A. Location B. Spigot
24	**GAC 4D**	GAC Vessel no. 2, (around backside opposite the Ozone destruct tank) Lowest port on the Vessel, Fourth from the Top sample port (D) near the bottom 90% of the bed.   A. Location B. Spigot

25	**GAC 4 Out**	GAC Vessel no. 4 is located closest to the storage shed. GAC 4 OUT sample port is located on the pipe exiting the GAC vessel.   A. Location B. Spigot
26	**Blend**	Sample port is located on the air release on the Pipe next to the storage shed, containing blended water of ozone and GAC prior to the control valve.   A. Location B. Spigot
27	**Pre GST**	Prior to the Ground Storage Tank (GST), next to the chlorination building, downhill of the GACs, pipe flowing to the GST. The sample port is prior to chlorination.   A. Location B. Spigot

28	**GST**	On the Ground Storage Tank, sample port located near the long sidewalk from the GACs  A. Location  B. Spigot
29	**Post GST**	Pipeline above thr ground after the GST tank, next to the chlorinatino building door. Sample port is prior to the chlorination point (first sample port after GST).  A. Location  B. Spigot
30	**POE**	Point of Entry, near the high service pumps on the air release valve (ARV) of the last flow section above ground pipe.  A. Location  B. Spigot